Notice of Allowability	Application No.	Applicant(s)	
	10/634,662	CHANG ET AL.	
	Examiner	Art Unit	
	Kelly Stouffer	1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *After-final amendment filed 17 April 2007*.

2. ☒ The allowed claim(s) is/are *1,2,4,5,7-11,14,16-18,20-22,24,27-31,33-37,55-61 and 64-75*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date 4/24 & 4/25/07.
7. ☒ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with John-Paul Cherry on 24 April 2007 and 25 April 2007, a summary of which is attached.

The application has been amended as follows:

Please cancel claims 13, 53-54, and 62-63, and amend the claims as follows:

1. (Currently Amended) A method for forming a ruthenium layer on a substrate, comprising:

positioning a substrate within a process chamber, wherein the process chamber comprises an expanding channel positioned to expose the substrate to a process gas comprising a ruthenium-containing compound or a reducing gas;

delivering the process gas from the expanding channel having a circular flow pattern; and

exposing the substrate sequentially to [[a]] the ruthenium-containing compound and [[a]] the reducing gas during an atomic layer deposition process to form a ruthenium material on the substrate, wherein the ruthenium-containing compound is selected from the group consisting of bis(2,4-dimethylpentadienyl) ruthenium, (2,4-dimethylpentadienyl) ruthenium (cyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (methylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (ethylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (isopropylcyclopentadienyl), derivatives thereof, and combinations thereof.

2. (Previously Presented) The method of claim 1, wherein the process chamber is purged with a purge gas and a deposition cycle of the atomic layer deposition process includes sequentially delivering the ruthenium-containing compound, the purge gas, the reducing gas, and the purge gas into the process chamber.

3. (Cancelled)

4. (Previously Presented) The method of claim 1, wherein the reducing gas comprises one or more reagents selected from the group consisting of hydrogen, atomic hydrogen, ammonia, silane, disilane, dimethylsilane, methylsilane, ethylsilane, chlorosilane, dichlorosilane, hexachlorodisilane, borane, diborane, triborane, tetraborane, pentaborane, triethylborane, derivatives thereof, and combinations thereof.

5. (Previously Presented) The method of claim 4, wherein the substrate is heated to a temperature of less than about 400°C and the process chamber is pressurized to a pressure of less than about 80 Torr.

6. (Cancelled)

7. (Original) The method of claim 2, wherein the purge gas is selected from the group consisting of helium, argon, hydrogen, nitrogen, and combinations thereof.

8. (Previously Presented) The method of claim 5, wherein the ruthenium-containing compound is pulsed into the process chamber for a duration within a range from about 0.05 seconds to about 1.5 seconds.

9. (Previously Presented) The method of claim 8, wherein the reducing gas is pulsed into the process chamber for a duration within a range from about 0.1 seconds to about 2 seconds.

10. (Previously Presented) The method of claim 7, wherein the purge gas is pulsed into the process chamber for a duration within a range from about 0.07 seconds to about 1 second.

11. (Previously Presented) The method of claim 4, wherein the ruthenium material is formed having a thickness within a range from about 10 Å to about 100 Å.

12. (Cancelled)

13. (Cancelled) ~~The method of claim 1, wherein the ruthenium-containing compound is exposed to the substrate from an expanding channel.~~

14. (Previously Presented) A method for forming a ruthenium layer on a substrate, comprising:

positioning a substrate within a process chamber comprising a lid assembly having a centralized expanding channel;

flowing a carrier gas towards the walls of the expanding channel and down the expanding channel towards the substrate, wherein a flow rate of the carrier gas decreases as the carrier gas travels through the expanding channel;

exposing the substrate to the carrier gas; and

exposing the substrate sequentially to a ruthenium-containing compound and a reducing gas to form a ruthenium material on the substrate, wherein the ruthenium-containing compound and the reducing gas are sequentially pulsed into the carrier gas and the ruthenium-containing compound comprises a 2,4-dimethylpentadienyl ligand.

15. (Cancelled)

16. (Previously Presented) The method of claim 14, wherein the ruthenium-containing compound is selected from the group consisting of
bis(2,4-dimethylpentadienyl) ruthenium,
(2,4-dimethylpentadienyl) ruthenium (cyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (methylcyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (ethylcyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (isopropylcyclopentadienyl), derivatives thereof, and combinations thereof.

17. (Previously Presented) The method of claim 16, wherein the reducing gas comprises one or more reagents selected from the group consisting of hydrogen, atomic hydrogen, ammonia, silane, disilane, dimethylsilane, methylsilane, ethylsilane, chlorosilane, dichlorosilane, hexachlorodisilane, borane, diborane, triborane, tetraborane, pentaborane, triethylborane, derivatives thereof, and combinations thereof.

18. (Previously Presented) The method of claim 17, wherein the substrate is heated to a temperature of less than about 400°C and the process chamber is pressurized to a pressure of less than about 80 Torr.

19. (Cancelled)

20. (Previously Presented) The method of claim 14, wherein the carrier gas is selected from the group consisting of helium, argon, hydrogen, nitrogen, and combinations thereof.

21. (Previously Presented) The method of claim 18, wherein the ruthenium-containing compound is pulsed into the carrier gas for a duration within a range from about 0.05 seconds to about 1.5 seconds.

22. (Previously Presented) The method of claim 21, wherein the reducing gas is pulsed into the carrier gas for a duration within a range from about 0.1 seconds to about 2 seconds.

23. (Cancelled)

24. (Previously Presented) The method of claim 17, wherein the ruthenium material is formed having a thickness within a range from about 10 Å to about 100 Å.

25-26. (Cancelled)

27. (Currently Amended) A method for forming a ~~layer comprising~~ ruthenium-containing material on a substrate ~~within a process chamber~~, comprising:

positioning a substrate within a process chamber, wherein the process chamber comprises an expanding channel positioned to expose the substrate to a process gas having a circular flow pattern; and

exposing the substrate to the process gas during an atomic layer deposition process cycle, comprising:

(a) exposing [[a]] the substrate to the process gas comprising a ruthenium-containing compound to form a ruthenium-containing layer thereon, wherein the ruthenium-containing compound comprises a 2,4-dimethylpentadienyl ligand ~~and a second ligand selected from the group consisting of cyclopentadienyl, methylcyclopentadienyl, ethylcyclopentadienyl, propylcyclopentadienyl, and derivatives thereof~~;

(b) purging the process chamber with a purge gas;

(c) exposing the substrate to the process gas comprising a reducing gas to form a ruthenium [[-]] ~~containing layer~~ material thereon; and

(d) purging the process chamber with the purge gas.

28. (Currently Amended) The method of claim 27, wherein the ruthenium material is ~~formed~~ deposited by repeating ~~an ALD~~ the atomic layer deposition process cycle of steps a-d.

29. (Currently Amended) The method of claim 28, wherein the ruthenium-containing compound is selected from the group consisting of
bis(2,4-dimethylpentadienyl) ruthenium,
(2,4-dimethylpentadienyl) ruthenium (cyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (methylcyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (ethylcyclopentadienyl),
(2,4-dimethylpentadienyl) ruthenium (isopropylcyclopentadienyl), derivatives thereof, and combinations thereof.

30. (Previously Presented) The method of claim 29, wherein the reducing gas comprises one or more reagents selected from the group consisting of hydrogen, atomic hydrogen, ammonia, silane, disilane, dimethylsilane, methylsilane, ethylsilane, chlorosilane, dichlorosilane, hexachlorodisilane, borane, diborane, triborane, tetraborane, pentaborane, triethylborane, derivatives thereof, and combinations thereof.

31. (Previously Presented) The method of claim 30, wherein the substrate is heated to a temperature of less than about 400°C and the process chamber is pressurized to a pressure of less than about 80 Torr.

32. (Cancelled)

33. (Original) The method of claim 28, wherein the purge gas is selected from the group consisting of helium, argon, hydrogen, nitrogen, and combinations thereof.

34. (Previously Presented) The method of claim 31, wherein the ruthenium-containing compound is pulsed into the process chamber for a duration within a range from about 0.05 seconds to about 1.5 seconds.

35. (Previously Presented) The method of claim 34, wherein the reducing gas is pulsed into the process chamber for a duration within a range from about 0.1 seconds to about 2 seconds.

36. (Previously Presented) The method of claim 33, wherein the purge gas is pulsed into the process chamber for a duration within a range from about 0.07 seconds to about 1 second.

37. (Previously Presented) The method of claim 30, wherein steps a-d are repeated to form the ruthenium material having a thickness within a range from about 10 Å to about 100 Å.

38-52. (Cancelled)

53. (Cancelled) ~~The method of claim 13, wherein the expanding channel is positioned to expose the substrate to a process gas comprising the ruthenium-containing compound or the reducing gas.~~

54. (Cancelled) ~~The method of claim 53, wherein the process gas is delivered from the expanding channel having a circular flow pattern.~~

55. (Currently Amended) The method of claim [[54]] 1, wherein a deposition cycle of the atomic layer deposition process includes sequentially delivering the ruthenium-containing compound and the reducing gas into the carrier gas.

56. (Previously Presented) The method of claim 55, wherein the reducing gas comprises a reagent selected from the group consisting of hydrogen, atomic hydrogen, ammonia, derivatives thereof, and combinations thereof.

57. (Previously Presented) The method of claim 56, wherein the process gas comprises a carrier gas selected from the group consisting of hydrogen, nitrogen, argon, helium, and combinations thereof.

58. (Currently Amended) The method of claim [[54]] 1, wherein the circular flow pattern is selected from the group consisting of a vortex pattern, a helix pattern, a spiral pattern, derivatives thereof, and combinations thereof.

59. (Previously Presented) The method of claim 14, wherein a circular flow pattern is formed as the carrier gas passes through the expanding channel.

60. (Previously Presented) The method of claim 59, wherein the reducing gas comprises a reagent selected from the group consisting of hydrogen, atomic hydrogen, ammonia, derivatives thereof, and combinations thereof.

61. (Previously Presented) The method of claim 59, wherein the circular flow pattern is selected from the group consisting of a vortex pattern, a helix pattern, a spiral pattern, derivatives thereof, and combinations thereof.

62. (Cancelled) ~~The method of claim 27, wherein the process chamber comprises an expanding channel positioned to expose the substrate to a carrier gas~~.

63. (Cancelled) ~~The method of claim 62, wherein the carrier gas is delivered from the expanding channel having a circular flow pattern~~.

64. (Currently Amended) The method of claim [[63]] 27, wherein the ruthenium-containing compound is pulsed into the ~~carrier~~ process gas.

65. (Currently Amended) The method of claim 64, wherein the purge gas is the ~~carrier~~ process gas.

66. (Previously Presented) The method of claim 65, wherein the reducing gas comprises a reagent selected from the group consisting of hydrogen, atomic hydrogen, ammonia, derivatives thereof, and combinations thereof.

67. (Currently Amended) The method of claim 65, wherein the ~~carrier~~ process gas comprises a gas selected from the group consisting of hydrogen, nitrogen, argon, helium, and combinations thereof.

68. (Previously Presented) The method of claim 67, wherein the circular flow pattern is selected from the group consisting of a vortex pattern, a helix pattern, a spiral pattern, derivatives thereof, and combinations thereof.

69. (Previously Presented) A method for forming a ruthenium layer on a substrate, comprising:

positioning a substrate on a substrate support within a process chamber;

flowing a carrier gas through an expanding channel substantially axially positioned with the substrate, wherein the carrier gas forms a circular flow pattern along the expanding channel; and

exposing the substrate to the carrier gas while pulsing a ruthenium-containing compound into the carrier gas to form a ruthenium material on the substrate.

70. (Previously Presented) The method of claim 69, wherein the carrier gas comprises a gas selected from the group consisting of hydrogen, nitrogen, argon, helium, and combinations thereof.

71. (Previously Presented) The method of claim 70, wherein the circular flow pattern is selected from the group consisting of a vortex pattern, a helix pattern, a spiral pattern, derivatives thereof, and combinations thereof.

72. (Previously Presented) The method of claim 69, wherein a reducing gas and the ruthenium-containing compound are sequentially pulsed into the carrier gas and the reducing gas comprises a reagent selected from the group consisting of hydrogen, atomic hydrogen, ammonia, silane, disilane, diborane, derivatives thereof, and combinations thereof.

73. (Previously Presented) The method of claim 69, wherein the ruthenium-containing compound and a reducing gas are sequentially pulsed into the carrier gas and the ruthenium-containing compound comprises a 2,4-dimethylpentadienyl ligand.

74. (Previously Presented) The method of claim 73, wherein the ruthenium-containing compound is selected from the group consisting of bis(2,4-dimethylpentadienyl) ruthenium, (2,4-dimethylpentadienyl) ruthenium (cyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (methylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (ethylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (isopropylcyclopentadienyl), derivatives thereof, and combinations thereof.

75. (Previously Presented) The method of claim 69, wherein the ruthenium-containing compound is selected from the group consisting of tris(2,2,6,6-tetramethyl-3,5-heptanedionato) ruthenium, bis(2,4-dimethylpentadienyl) ruthenium, dicarbonyl pentadienyl ruthenium, ruthenium acetyl acetonate, (2,4-dimethylpentadienyl) ruthenium (cyclopentadienyl), bis(2,2,6,6-tetramethyl-3,5-heptanedionato) ruthenium (1,5-cyclooctadiene), (2,4-dimethylpentadienyl) ruthenium (methylcyclopentadienyl), (1,5-

cyclooctadiene) ruthenium (cyclopentadienyl), (1,5-cyclooctadiene) ruthenium (methylcyclopentadienyl), (1,5-cyclooctadiene) ruthenium (ethylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (ethylcyclopentadienyl), (2,4-dimethylpentadienyl) ruthenium (isopropylcyclopentadienyl), bis(N,N-dimethyl 1,3-tetramethyl diiminato) ruthenium (1,5-cyclooctadiene), bis(N,N-dimethyl 1,3-dimethyl diiminato) ruthenium (1,5-cyclooctadiene), bis(allyl) ruthenium (1,5-cyclooctadiene), (η^6-C_6H_6) ruthenium (1,3-cyclohexadiene), bis(1,1-dimethyl-2-aminoethoxylato) ruthenium (1,5-cyclooctadiene), bis(1,1-dimethyl-2-aminoethylaminato) ruthenium (1,5-cyclooctadiene), derivatives thereof, and combinations thereof.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kelly Stouffer whose telephone number is (571) 272-2668. The examiner can normally be reached on Monday - Thursday 7:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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Examiner
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